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CHESAPEAKE BAY BRIDGE

by E. F. Ball, M. ASCE

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CONSTRUCTION DIVISION

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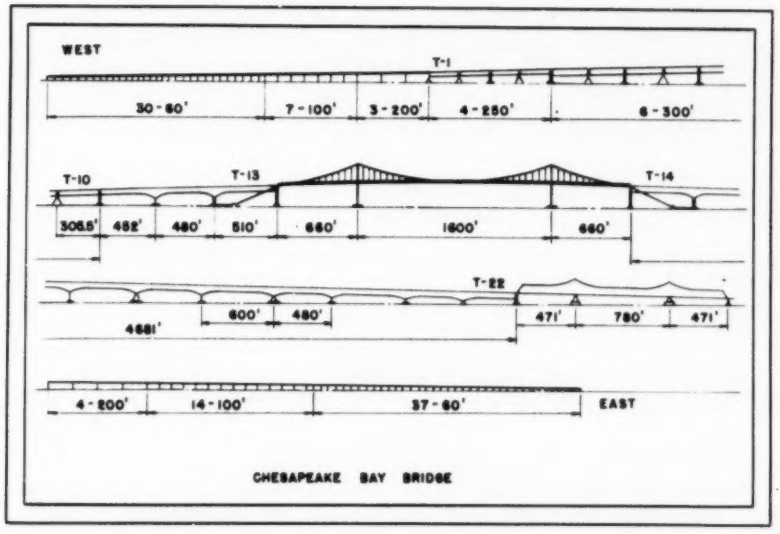
CHESAPEAKE BAY BRIDGE

E. F. Ball[1]

The contract for the Superstructure of the Chesapeake Bay Bridge was awarded to Bethlehem Steel Company, after competitive bidding on plans prepared by J. E. Greiner Company, on October 24th-1949. The contract covered 37 different items which included 14 items of fabricated structural steel, 4 items of cable and accessories, 9 items of flooring and deck, 2 items of railing, and 8 items of miscellaneous work.

The Cable strands and suspender ropes, with sockets, were purchased from the John A. Roebling's Sons Company of Trenton, New Jersey, but were erected by Bethlehem. Furnishing and placing of the concrete deck items was sublet to the Kaufman Construction Company of Philadelphia, Pa. All other items were furnished and erected by Bethlehem.



Slide 1

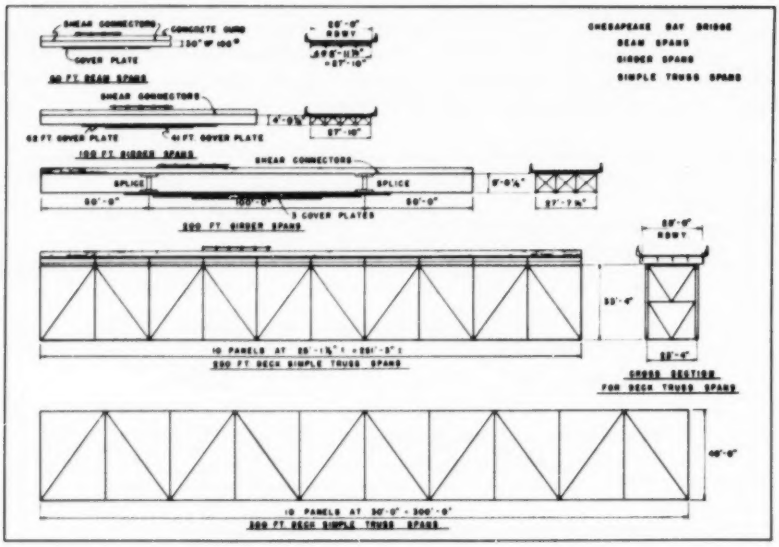
This view shows a simplified elevation of the superstructure, starting wit. the West abutment at the upper left and continuing to the East abutment at the lower right an overall length of 4 miles. The number and length of the various spans is noted.

[1]Chief Engineer, Bethlehem Steel Company, Bethlehem, Pa.

Shop fabrication of the steelwork was distributed to three of our Works. Beam spans were of all welded construction and fabricated at the welding shop at Bethlehem. Riveted plate girder spans were fabricated at Rankin Works which also fabricated the simple truss spans and the through cantilever span. The deck cantilever spans with their supports were fabricated at Pottstown Works as were the structural steel parts of the suspension bridge.

Material was rolled at various Bethlehem Mills and shipped by rail to the fabricating shops noted above, and after fabrication shipped by rail to a yard in Baltimore where it was stored until needed. Bridge members were barged to the site when the erection crew was ready to erect them.

Detail shop drawings were made at the various fabricating shops. Needless to say there were a great number of drawings required on account of the many different kinds of spans in the bridge.

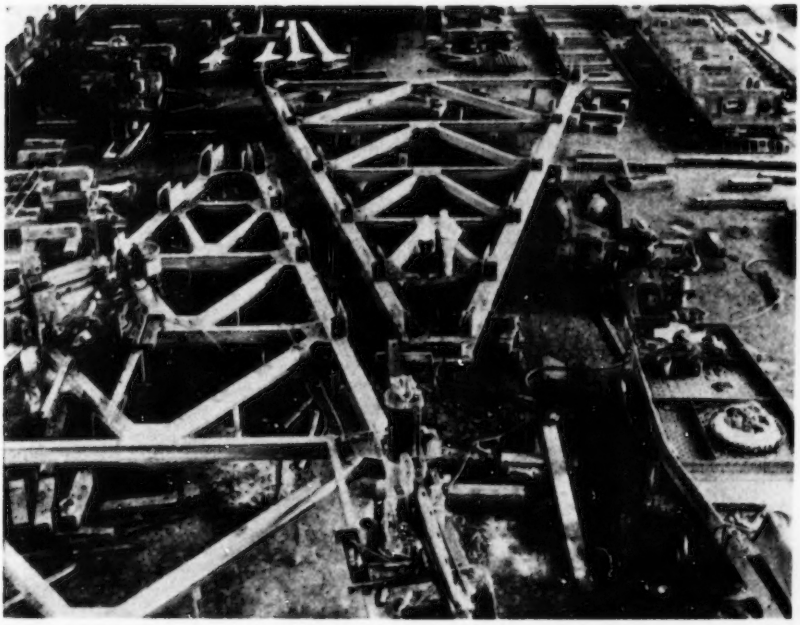


Slide 2

The shop fabrication did not involve any unusual problems as the various types of members were of conventional design. All workmanship was in accordance with Maryland State Highway Specifications. The 60 foot beam spans comprised five lines of 30-inch rolled wide-flange beams with cover-plates welded to the bottom flange and Zee shear connectors welded to the top flange. The plate girder spans were of standard riveted construction except that Zee shear connectors were welded or riveted on the top flange for composite action with the concrete slab.

The trusses, bents and towers were of the usual riveted construction. Chords and web members for the long spans were designed with perforated coverplates in accordance with modern practice.

The pyramidal towers presented some problems in the Shop to make sure that all angles were correct.



Slide 3

This view shows the assembly of two of the four faces of one such tower; the upward-projecting gusset plates will receive in the field the members which constitute the trussing of the other two faces. The drill in the foreground is reaming out some of the rivet holes.

(Slide 4)

One of these tower bents is blocked up on a slope in front of a milling machine which produces the smooth bearing in an inclined plane across the upper ends of the two columns.

The 480 foot deck cantilever spans required unusually accurate fabrication in order to insure proper fitting during erection.

(Slide 5)

The curved bottom chords were assembled for the full length of the span, end to end, as shown here, in order that the splices between the sections could be properly fitted and reamed. At this stage the over-all dimensions and shape were carefully checked with steel tapes and transit.

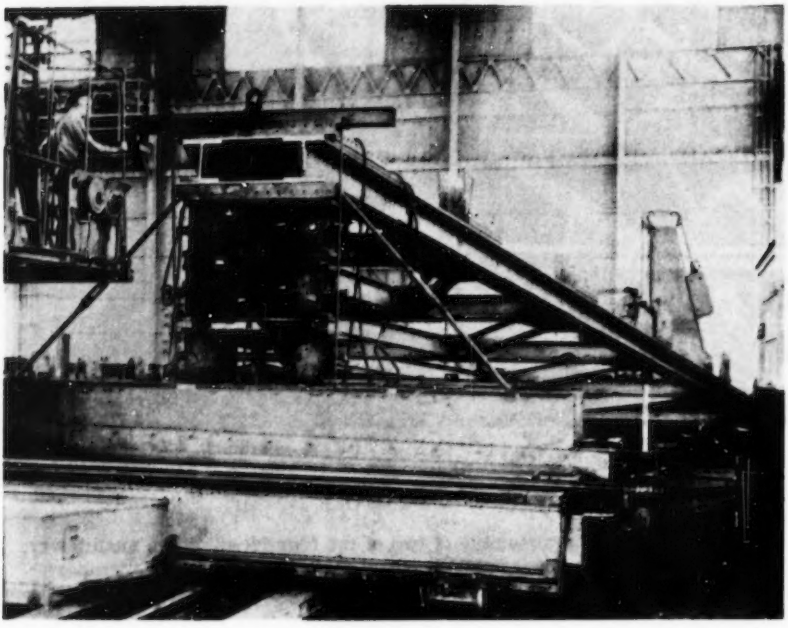
(Slide 6)

Through the deepest portion of the deck cantilever trusses, over their supports, the work was thought to be sufficiently critical that the entire truss, comprising upper and lower chords and connecting web members, was completely assembled for reaming. At other locations, the web members were in general reamed separately from metal templets used for reaming the chord gussets to which they would attach in the field.

There were no other features of special interest in the shop fabrication but there were many unusual and interesting schemes developed to erect the different spans in the field.

The 60-foot beam spans and 100-foot girder spans were erected in a conventional manner from barges by means of a tower derrick boat designed by Bethlehem's Erection Department.

Most other spans, except the Cable Suspension Bridge, were floated into position, either high or low, starting with the 200-foot girder spans.



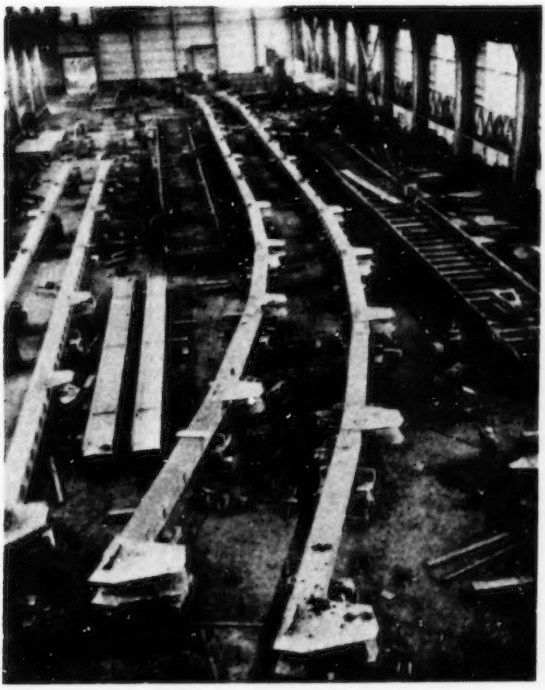
Slide 4

(Slide 7)

These girder spans were divided for shipment into a 50-foot section at each end and a 100-foot central section. Over a 100-foot gap purposely left in the approach, the right hand 50-foot section was erected, cantilevering into the opening. Then the erection of the 100-foot central section brought its left end over a support on the left-hand beam span. The final 50-foot section was then added over the beam span. The 200-foot span thus completed was ready for floating into final position.

(Slide 8)

Two barges with falsework, partially submerged at proper elevation, were floated under the girder span and lifted by pumping water out, causing them to rise. The span is shown on the way out to its final position, where it was landed on the piers by again partially flooding the barges and causing them to lower.



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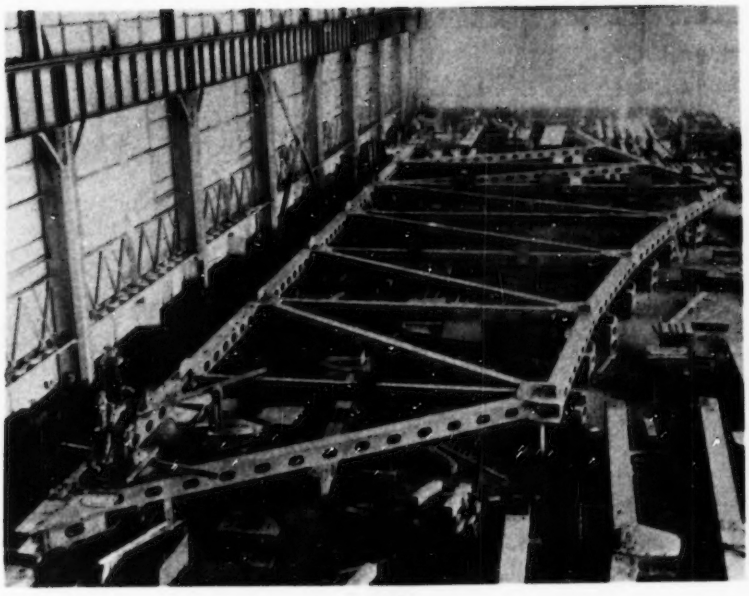

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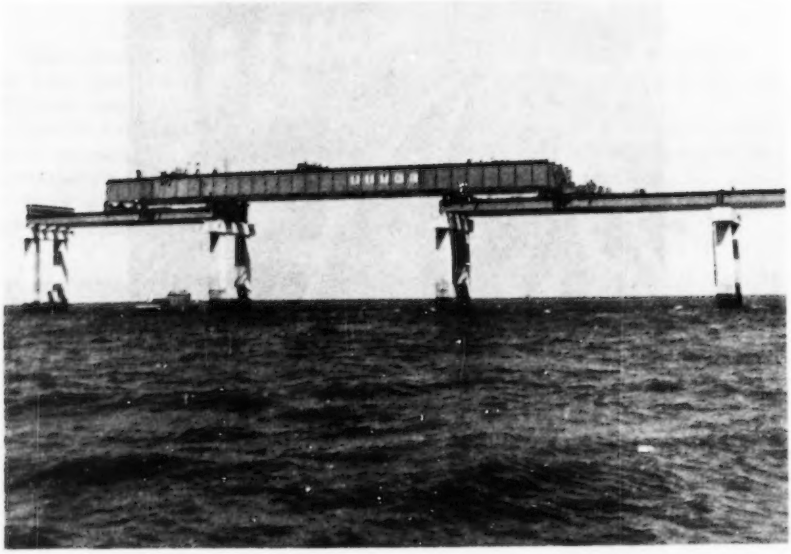

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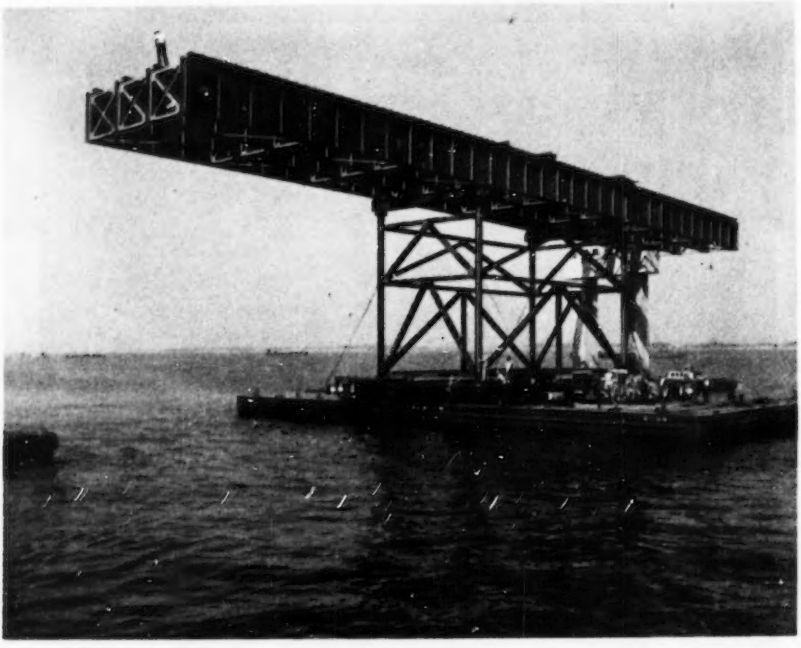


Slide 8

Slide 9

The barges used were designed and built by Bethlehem. They were 32 feet wide by 128 feet long by 9-1/2 feet deep. They contained four watertight bulkheads forming two end buoyancy chambers, and three flooding compartments equipped with flooding valves, pumps and depth gauges.

Truss spans of the type used in this bridge usually would be erected by driving groups of falsework piles under each span to support the superstructure on temporary steel bents until the complete span would become self-supporting. However at Chesapeake Bay, the bottom was so deep and soft that a completely different system had to be adopted.

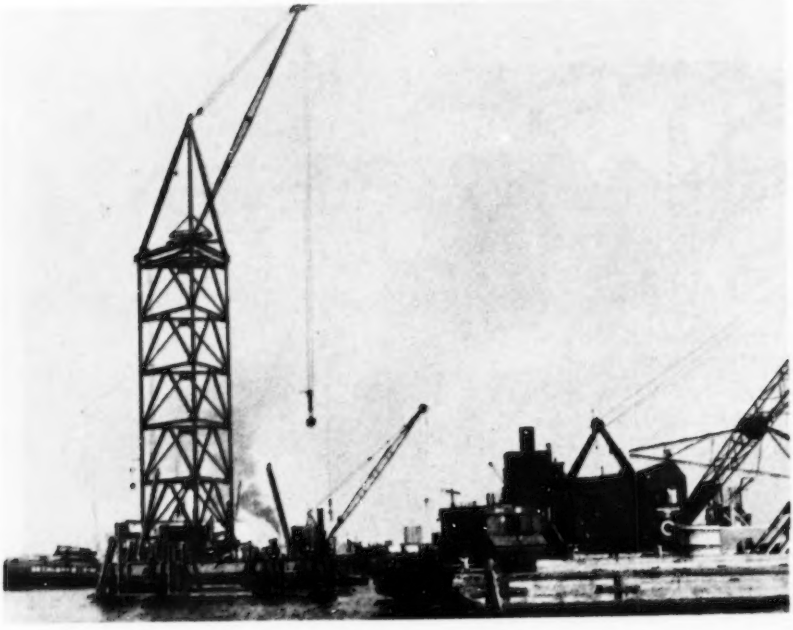
(Slide 10)

Only one set of falsework was used, an erection "dock" on steel piles erected alongside truss span T10, which was the highest of the 300-foot deck truss spans located about one mile from the west shore. The slide shows our tower derrick driving 100-foot steel H-piles and constructing the falsework dock.

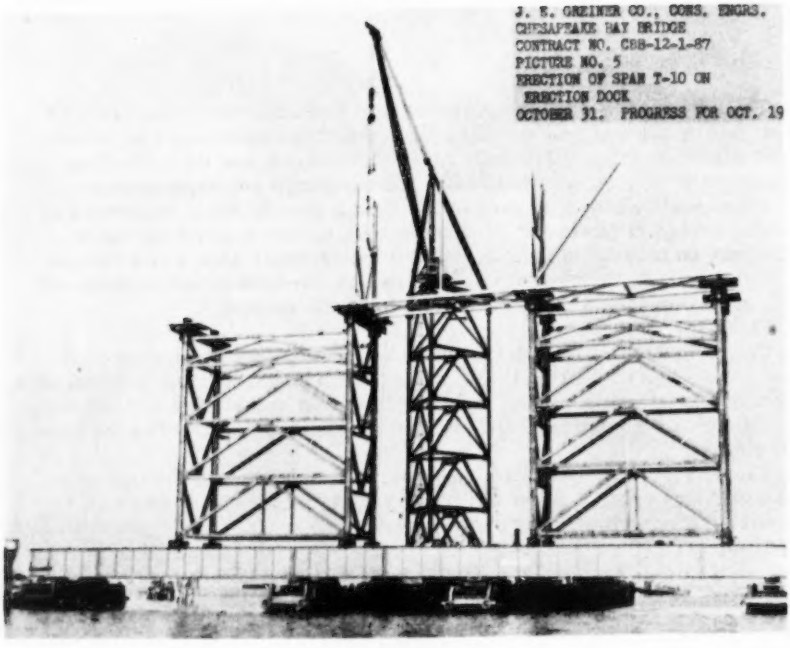
The derrick boat completed four steel pile clusters with grillage over them and then erected one of the 200-foot plate girder spans with a 25-foot special section spliced on at each end.

(Slide 11)

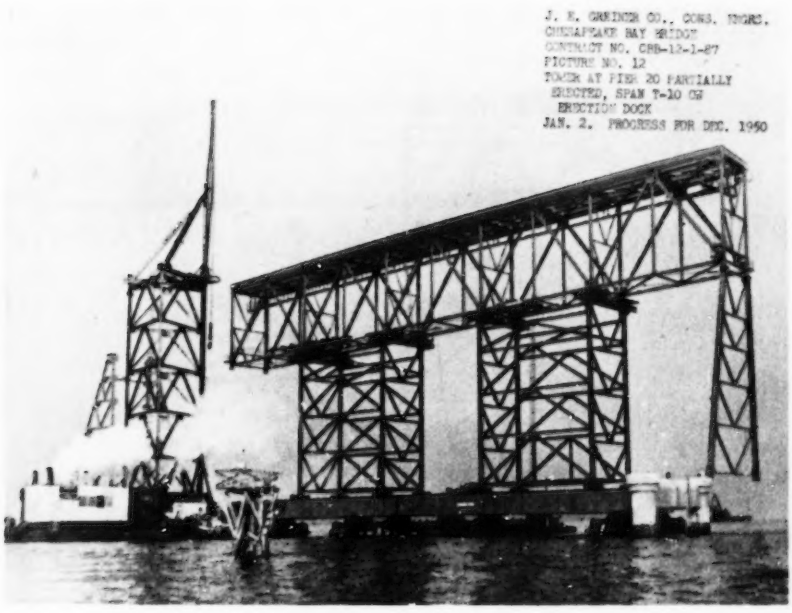
On top of these girders it next constructed two falsework towers, and on these towers it is shown erecting parts of Span T10.



Slide 10


J. E. GREINER CO., CONS. ENGRS.
CHESAPEAKE BAY BRIDGE
CONTRACT NO. CBB-12-1-87
PICTURE NO. 5
ERECTION OF SPAN T-10 ON
ERECTION DOCK
OCTOBER 31. PROGRESS FOR OCT. 19

Slide 11


J. E. GREINER CO., CONS. ENGRS.
CHESAPEAKE BAY BRIDGE
CONTRACT NO. CBB-13-1-47
PICTURE NO. 12
TOWER AT PIER 20 PARTIALLY
ERECTED, SPAN T-10 ON
ERECTION DOCK
JAN. 2. PROGRESS FOR DEC. 1950

Slide 12

After T10 was completely erected, including the hinged supporting bent at the right hand end, two pairs of partially submerged flotation barges were brought in under the girder span and blocked against its underside. The barges were pumped out, the entire span and upper falsework lifted off the piling supports, and moved laterally by wire-rope tackle to its permanent position on center line of bridge.

(Slide 13)

The barges were then flooded again, and lowered along with the falsework, and moved back to the original position on the pile clusters.

(Slide 14)

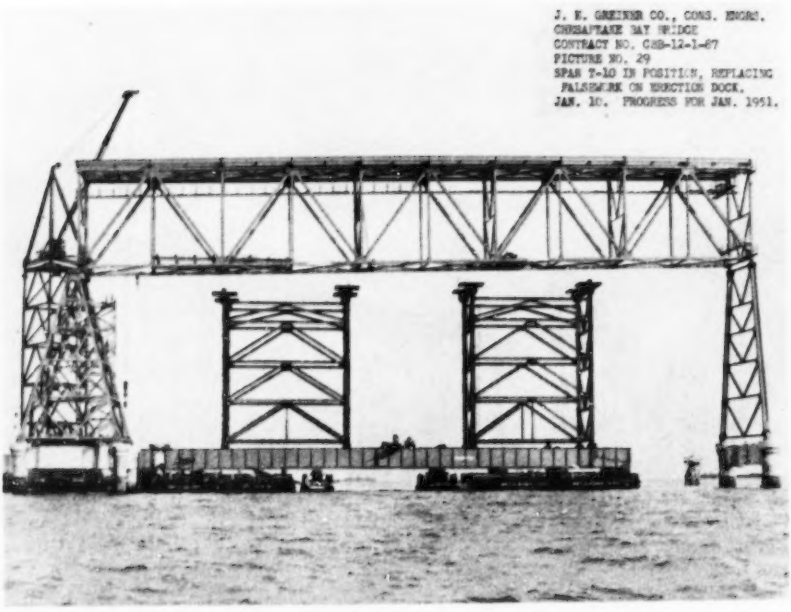
On top of span T10, the derrick boat erected two stiffleg derrick travelers, as shown. They moved back and forth along the deck of T10 and erected succeeding spans on the falsework. Each span was moved out from the dock with cables from engines on flotation barges to anchors, and then towed to its permanent location by tugboats.

(Slide 15)

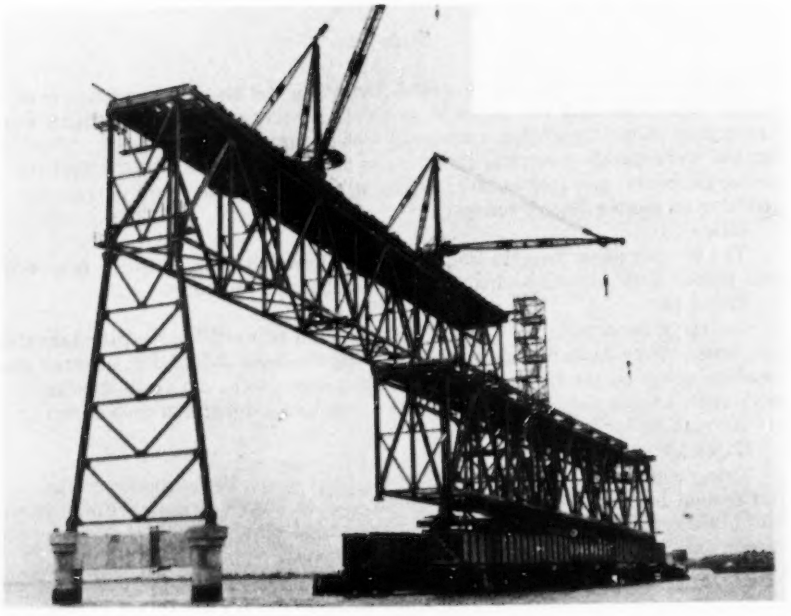
This view shows one of the 480-foot anchor spans being moved to its permanent location. The plate girder falsework shown in the previous views had to be replaced by the truss span here shown on account of the great length and height of these deck cantilever spans.

The spans were erected on the dock and floated slightly above their final elevation in order to clear anchor bolts for the shoes.

When the spans were close to their final location opposite to their piers, they were moved into position by means of cables.


J. E. GREINER CO., CONS. ENGRS.
CHESAPEAKE BAY BRIDGE
CONTRACT NO. CHB-12-1-47
PICTURE NO. 29
SPAN T-10 IN POSITION, REPLACING
FALSEWORK ON ERECTION DOCK.
JAN. 10. PROGRESS FOR JAN. 1951.

Slide 13



Slide 14

J. E. GRINNER CO., CONS. ENGRS.
CHESAPEAKE BAY BRIDGE
CONTRACT NO. CBB-12-1-57
PICTURE NO. 106
FLOATING SPAN T-19 INTO POSITION
27 JULY. PROGRESS FOR JULY 1951

Slide 15

(Slide 16)

This view shows two of the 480-foot anchor spans in position, one on the right and one in the distance. The 600-foot intervening cantilever span is being filled in by two pieces of equipment. At the left end a light stiffleg derrick traveler running on the top deck is building out the cantilever arm and half of the simple span. At the right end the tower derrick boat is performing the same operation, and is much further advanced. In this phase the 600-foot span, carrying its own weight only with no floor slab or live load, can be cantilevered 300 feet from each end to meet in the middle. Then by the manipulation of hydraulic jacks in the truss chords the two halves can be connected and the stresses can be shifted so that there will be a 300-foot simple span in the center, supported at each end on a 150-foot cantilever arm.

(Slide 17)

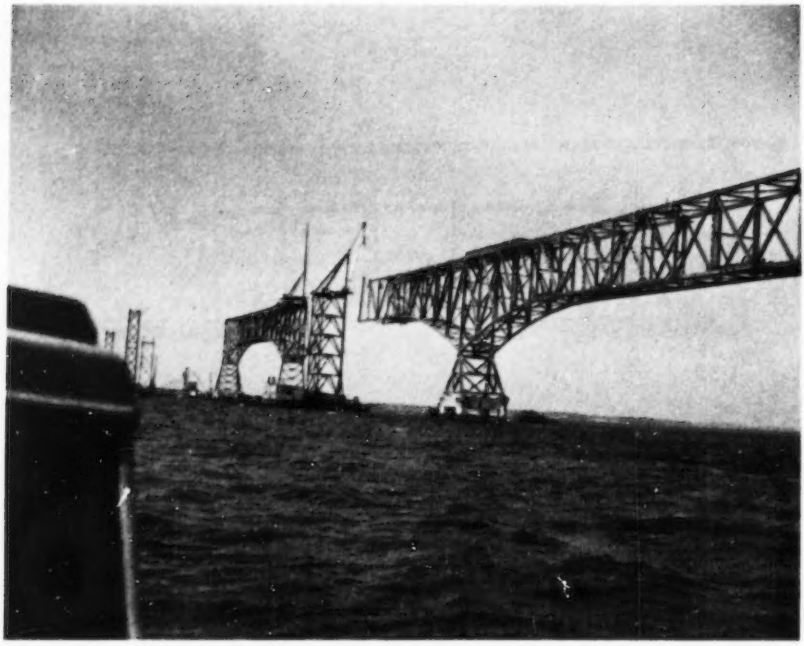
The anchor arms for the through cantilever span were erected and floated at high level in a similar manner. The cantilever arms and their supported simple span were erected by cantilevering as described for the deck cantilever spans.

It was found impractical to float three of the truss spans at high level. They were the two spans at the ends of the suspension bridge and one span at the west end of the through cantilever span.

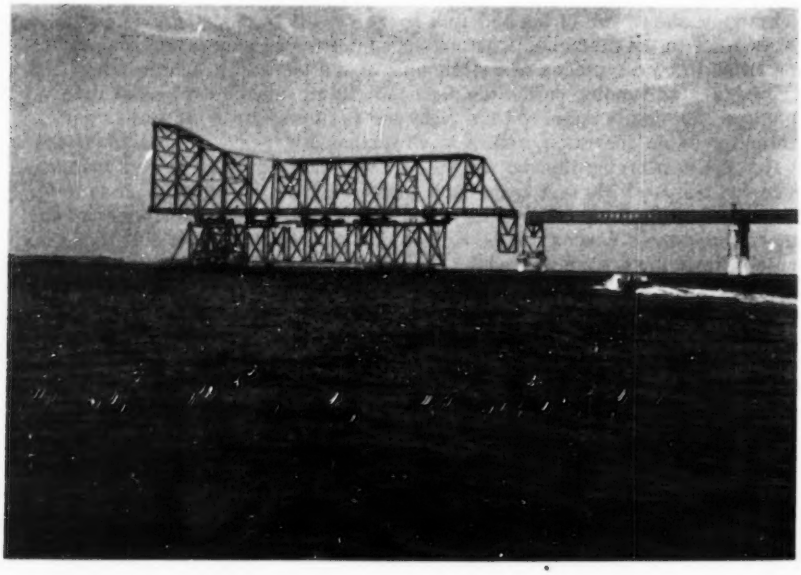
(Slide 18)

These spans were each erected on a car float at Baltimore Dock and floated to the site at low level as indicated in the lower sketch on this slide. They were then raised by four sets of lifting tackle and hoisted to their final elevation.

The suspension bridge over the main navigation channel was erected by conventional methods.

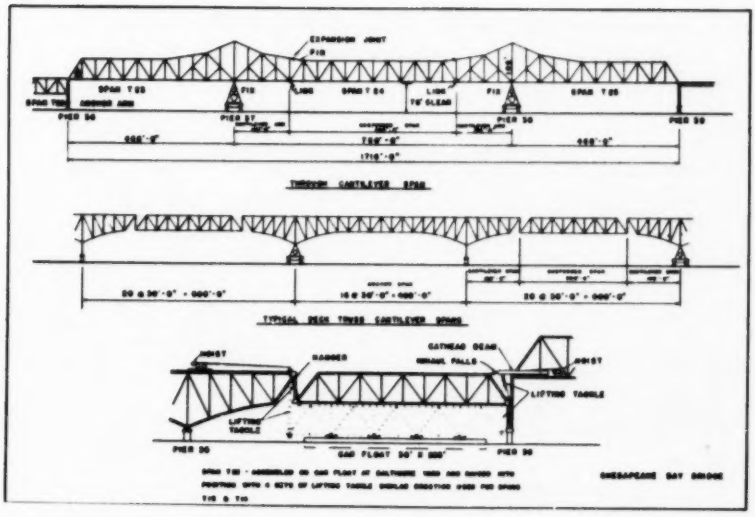


Slide 16



Slide 17

304-12



Slide 18

(Slide 19)

The two main shafts in each of the main span towers were composed of four rectangular plate and angle sections which, when assembled, form a cruciform cross section containing five interior squares just large enough for the passage of workmen. The first six tiers of each shaft were erected by the derrick boat as indicated in the lower left corner of the slide. The derrick boat then erected a Chicago Boom on one shaft. This Boom erected the seventh tier of the other shaft and then a second Chicago Boom. The two Chicago Booms then stepped up alternately to complete the tower which was 347 feet high.

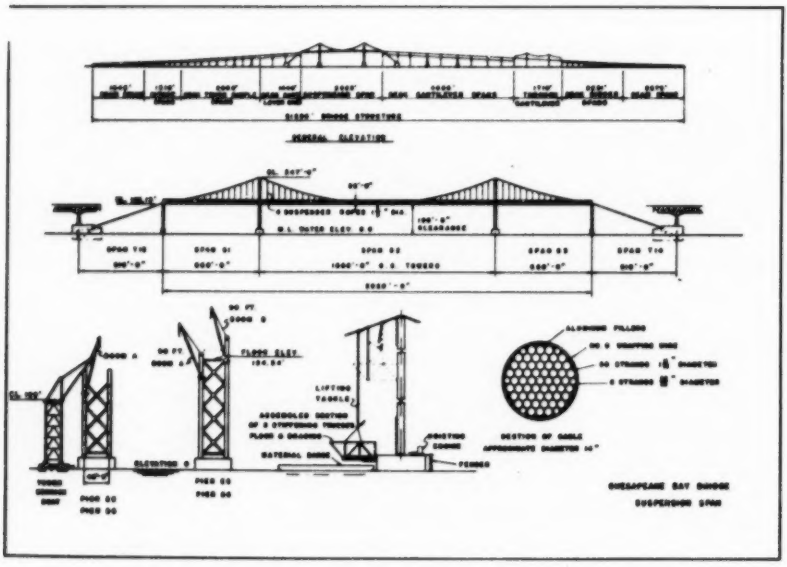
Each of the two cables was composed of 55 pre-stressed strands of 1-11/16" diameter and 6 strands of 29/32" diameter, arranged in an approximate circle. They were rounded out with extruded aluminum fillers and wrapped with #9 soft galvanized wire, to produce a finished diameter of about 14 inches.

(Slide 20)

To erect the cables, footwalks were first constructed from anchorage to anchorage across the tower tops as shown in this view. The footwalks were supported on wire ropes strung across the channel with tugs and barges and lifted into position by derricks on top of the two main towers.

(Slide 21)

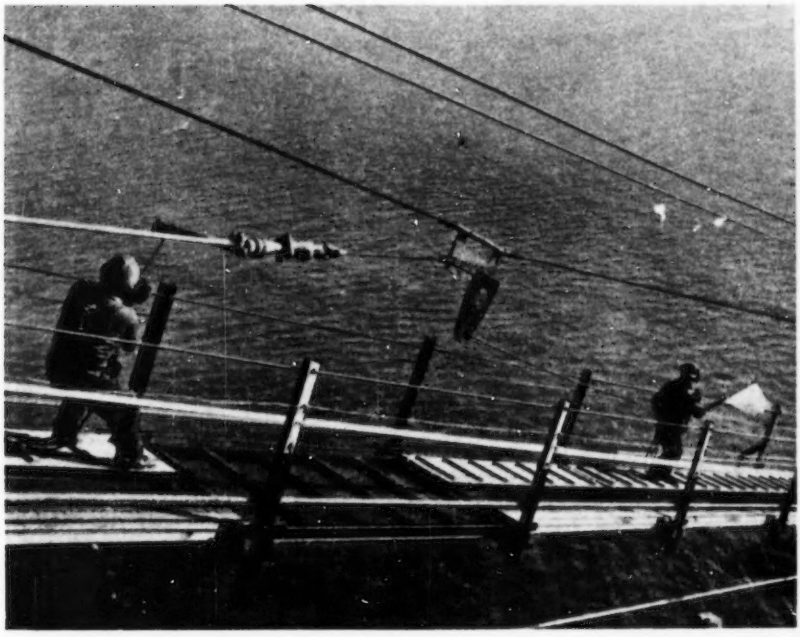
Bridge strands 1-11/16" diam. forming the cable wire pulled across the span by an endless hauling rope as shown in this view. The strands were measured in the shop to correct length and socketed. They were also marked in the shop to indicate where they were to be placed in the saddles on the towers in order to give a span of proper length and sag. The strands were "spun" during the day, but were adjusted at night to take advantage of a more uniform temperature and less wind.



Slide 19

J. E. GREINER CO., CONS. ENGRS.
CHESAPEAKE BAY BRIDGE
CONTRACT NO. CBB-12-1-57
PICTURE NO. 321
MAIN SPAN ERECTION, LOOKING WEST
FROM EAST ANCHORAGE.
1 FEB. PROGRESS FOR JAN. 1952

Slide 20



Slide 21

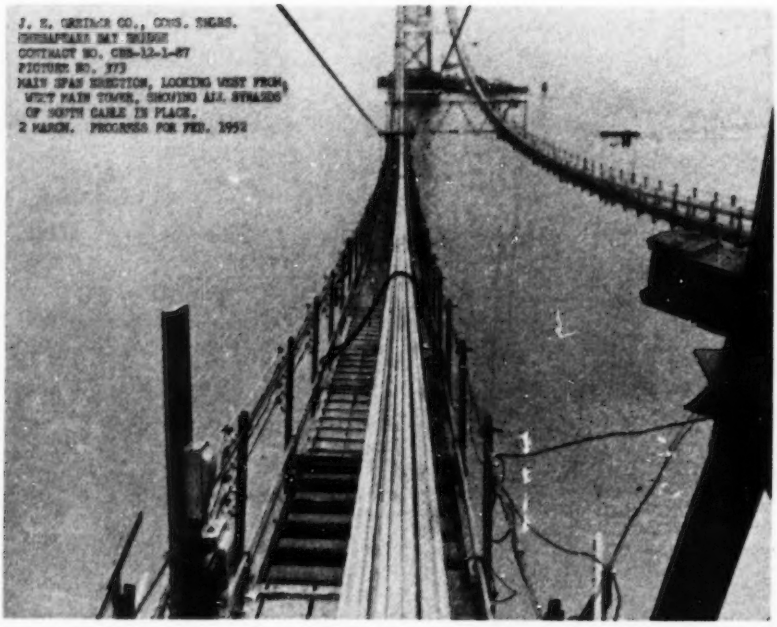
(Slide 22)

This is a view taken from the top of one of the main towers looking down along the line of one of the cables. Electric light and telephone wires are shown attached to the railing of the footwalk.

After the strands were compacted into as tight a cable as possible, cable bands were carried out on a light falls from the tramway rope and attached at intervals of about 41 feet for the support of the suspender ropes.

(Slide 23)

This view shows a cable band being attached. The bands were made of welded steel plates bent to cylindrical form, with interior zinc liners cast to the same shape as the exterior of the strand group. The bands were clamped around the cables with highly torqued high strength bolts to prevent slipping. The suspenders were 1-1/2 inch high strength wire strands.

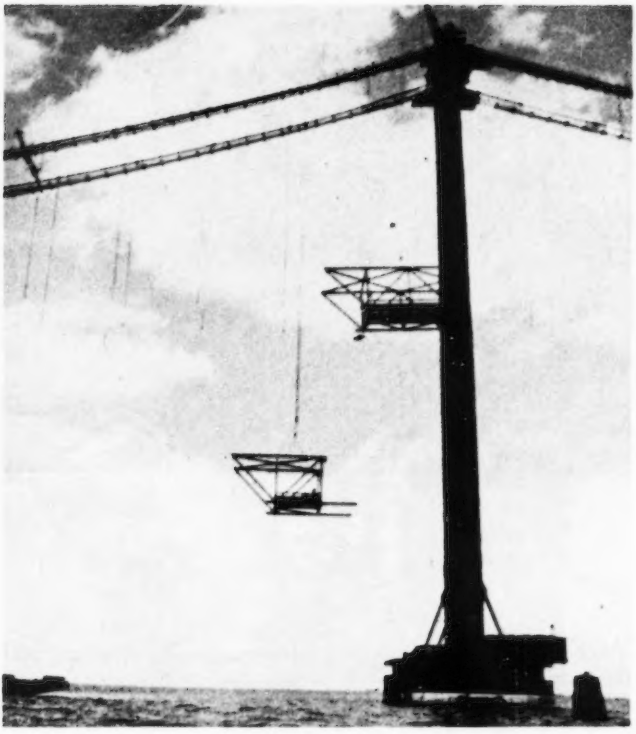

J. E. GREINER CO., CONS. ENGRS.
CHESAPEAKE BAY BRIDGE
CONTRACT NO. CBB-12-1-47
PICTURE NO. 373
MAIN SPAN ERECTION, LOOKING WEST FROM,
WEST MAIN TOWER, SHOWING ALL STRANDS
OF SOUTH CABLE IN PLACE.
2 MARCH, PROGRESS FOR FEB. 1952

Slide 22

Slide 23

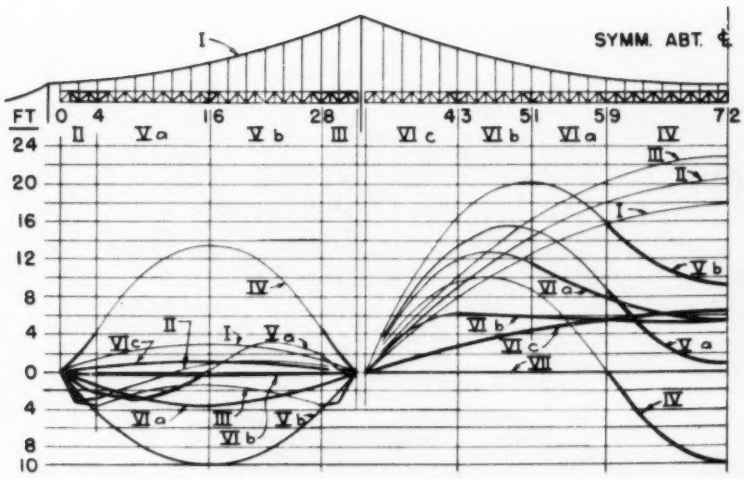
Slide 24

The floor system comprising stiffening trusses, floorbeams, stringers, and bracing, was pre-assembled on barges at the Baltimore dock, mostly in two-panel lengths, and towed to the site. Note the one panel of loose floor steel to fill in between each assembled section, stored on the deck.



Slide 25

The floor sections were hoisted into place from the barges by means of falls attached to special supports temporarily clamped to the cables. This view shows how the truss sections were assembled to avoid interference between top and bottom chords as they were raised into place.



NORMAL TRUSS OUTLINE IS USED AS BASIS FOR PLOTTING TRUSS DEFLECTIONS.

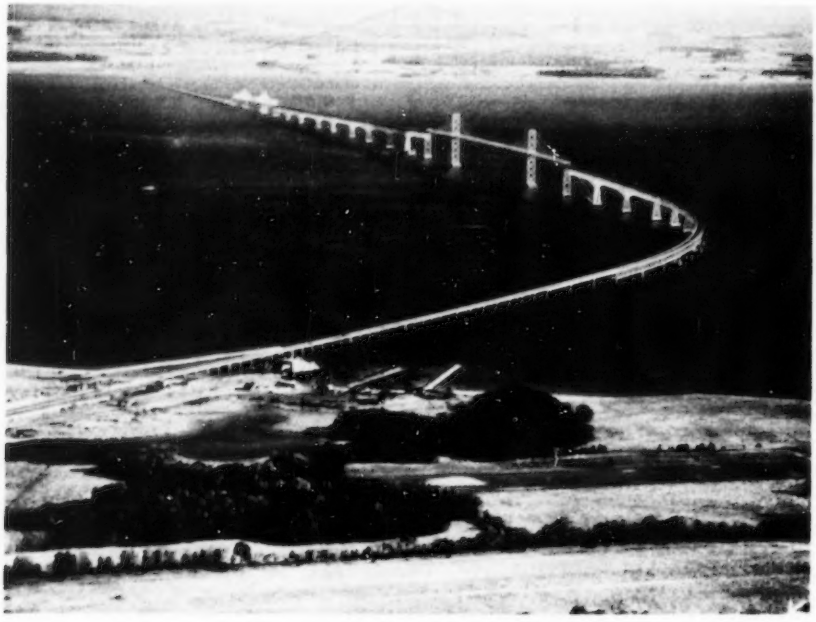
ERECTED PORTIONS OF TRUSS ARE SHOWN IN HEAVY LINES.

Slide 26

Floor sections were raised and hung on the suspenders following a predetermined schedule. This slide gives a hint of the calculations and study required to obtain a sequence which avoided too great distortions in the shape of the highly flexible cable. Note the maximum vertical movement during erection from 23 ft. above to 10 ft. below normal, a range of 33 ft.

Concrete deck, asphalt paving and railing construction proceeded simultaneously from East and West abutments.

The final operations in construction were the cable wrapping and the finish painting.



Slide 27

This view shows the completed structure as seen from an airplane over the West Shore.

The bridge was opened to traffic on July 30th-1952 and added an important link to the modern highway system along the Atlantic Coast.

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